



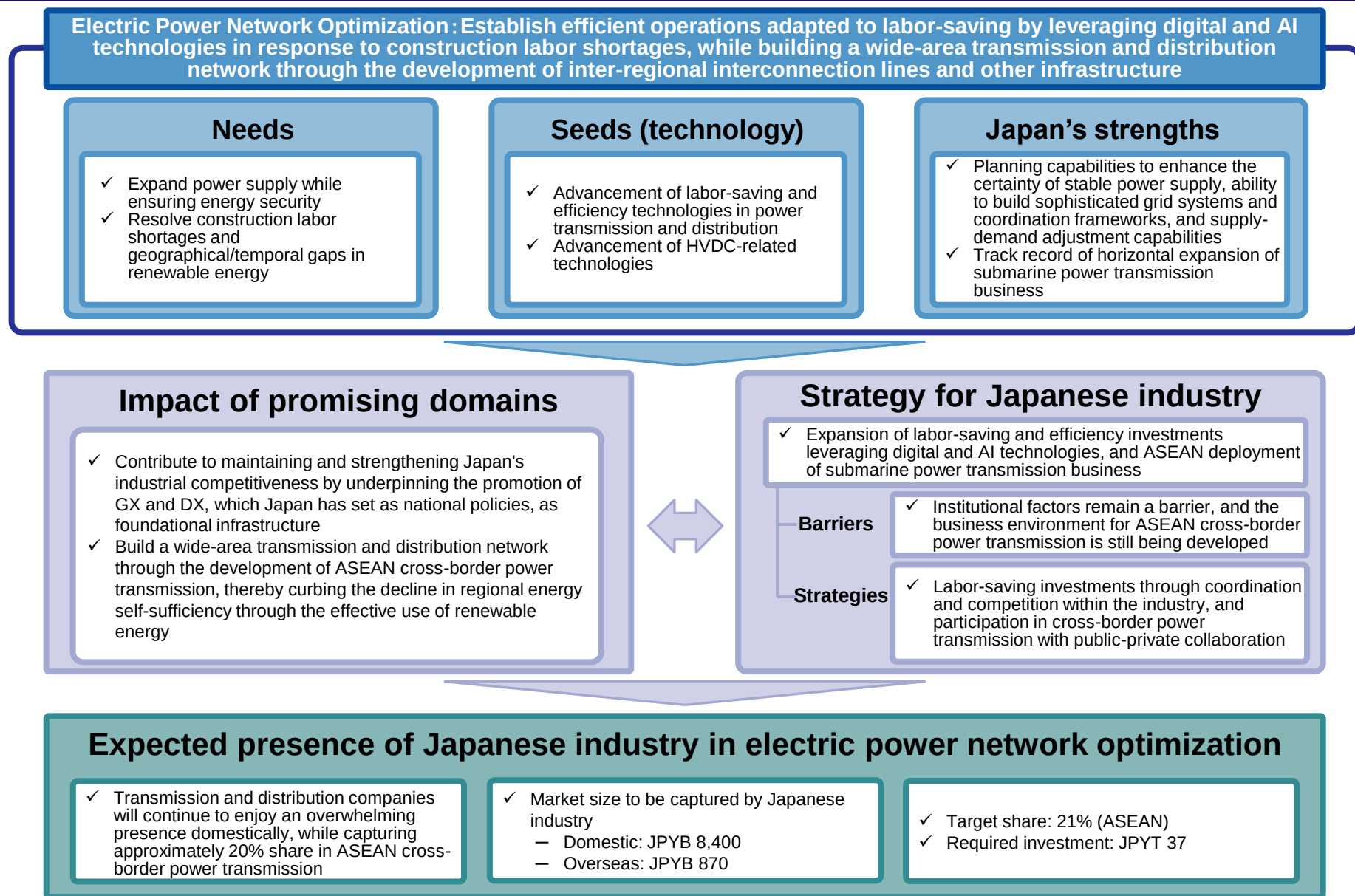
Electric Power Network Optimization

Labor-saving and efficiency investments for maximum utilization of renewable energy and construction of a wide-area transmission network

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Industry Research Department
Mizuho Bank

Strategy for capturing the electric power network optimization market and the expected presence of Japan in 2040



Labor-saving and efficiency investments and construction of a wide-area transmission network as strategies for maximum utilization of renewable energy

■ Background and Issues

- Given that Japan is an island nation with limited resources, maintenance and expansion of the transmission and distribution network is necessary to ensure stability of supply, economic efficiency, and environmental performance of energy, while also maximizing the utilization of variable renewable energy. However, Japan faces challenges including construction labor shortages, and variable renewable energy entails geographical and temporal gaps between demand and supply
- To overcome these challenges and realize maximum utilization of renewable energy as a domestically produced energy source, Japanese power companies are required to establish a transmission and distribution business framework capable of sustainable grid investment through labor-saving and efficiency improvements. In addition, given the need for wide-area transmission and distribution network development for the deployment of renewable energy, expanding participation in overseas power transmission businesses is also an option for Japanese companies

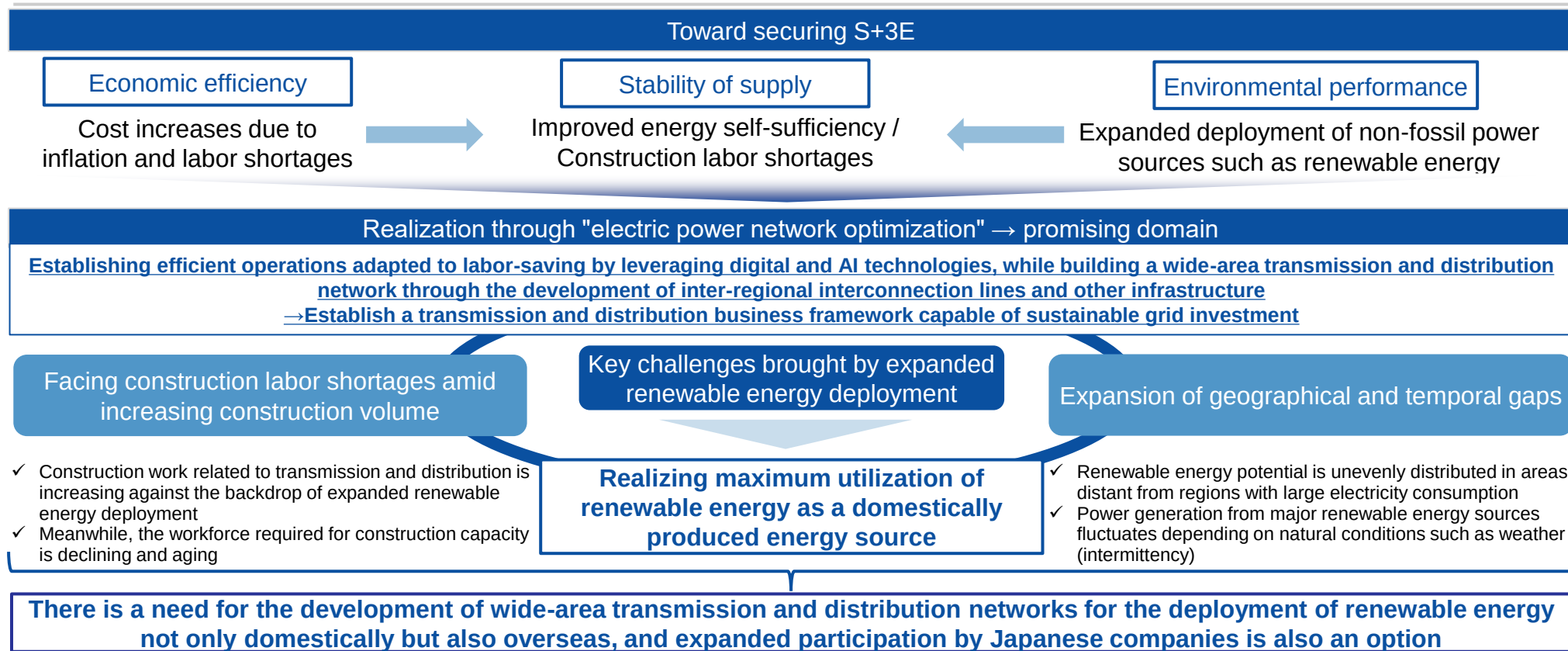
■ Summary

- Beyond ensuring stable power supply within the region, needs are also emerging in ASEAN from the perspective of effective utilization of renewable energy, with growing interest in building a wide-area power grid as the ASEAN Power Grid (APG)
- To resolve the geographical and temporal gaps between demand and supply of variable renewable energy, deployment of remote power sources such as offshore wind and strengthening of inter-regional interconnection are expected, against the backdrop of advances in High-Voltage Direct Current (HVDC)-related technologies
- Furthermore, in light of construction labor shortages, initiatives to expand transmission capacity and to achieve labor-saving and efficiency improvements by leveraging technologies such as AI and drones also become important
- Japanese power companies need to maintain their strengths in planning capabilities, ability to build sophisticated grid systems and coordination frameworks, and supply-demand adjustment capabilities, which enhance the certainty of stable power supply. As a country facing advanced challenges, it is urgently necessary to proactively undertake labor-saving and efficiency investments in transmission and distribution in anticipation of worsening construction labor shortages
- A sustainable transmission and distribution business framework capable of grid investment can be established by industry-wide advocacy to the government for institutional measures that contribute to promoting labor-saving and efficiency investments leveraging digital and AI technologies, while making investments through coordination and competition
- Construction of a wide-area transmission and distribution network responding to the needs of ASEAN countries, where energy integration on the scale of the EU is difficult to envisage, will not only present business opportunities leveraging the business experience and technologies of Japanese companies, but will also be an area contributing to the promotion of the AZEC initiative by helping ASEAN effectively utilize renewable energy. Engagement from the business environment development stage through public-private collaboration is also an option

Establishing a framework capable of sustainable grid investment for maximum utilization of renewable energy through "electric power network optimization"

- In Japan, maintenance and expansion of the transmission and distribution network, which is indispensable for maximum utilization of renewable energy, is required. "Electric Power Network Optimization," which establishes efficient operations that address labor-saving needs by leveraging digital and AI technologies in response to construction labor shortages while building a wide-area transmission and distribution network through grid reinforcement via the development of inter-regional interconnection lines and other infrastructure, emerges as a Promising Domain
- Establishing a transmission and distribution business framework capable of sustainable grid investment will enable maximum utilization of renewable energy as a domestically produced energy source. Overseas, there is also a need for the development of wide-area transmission and distribution networks for the deployment of renewable energy, and expanded participation by Japanese companies is also an option

Overview of "electric power network optimization"

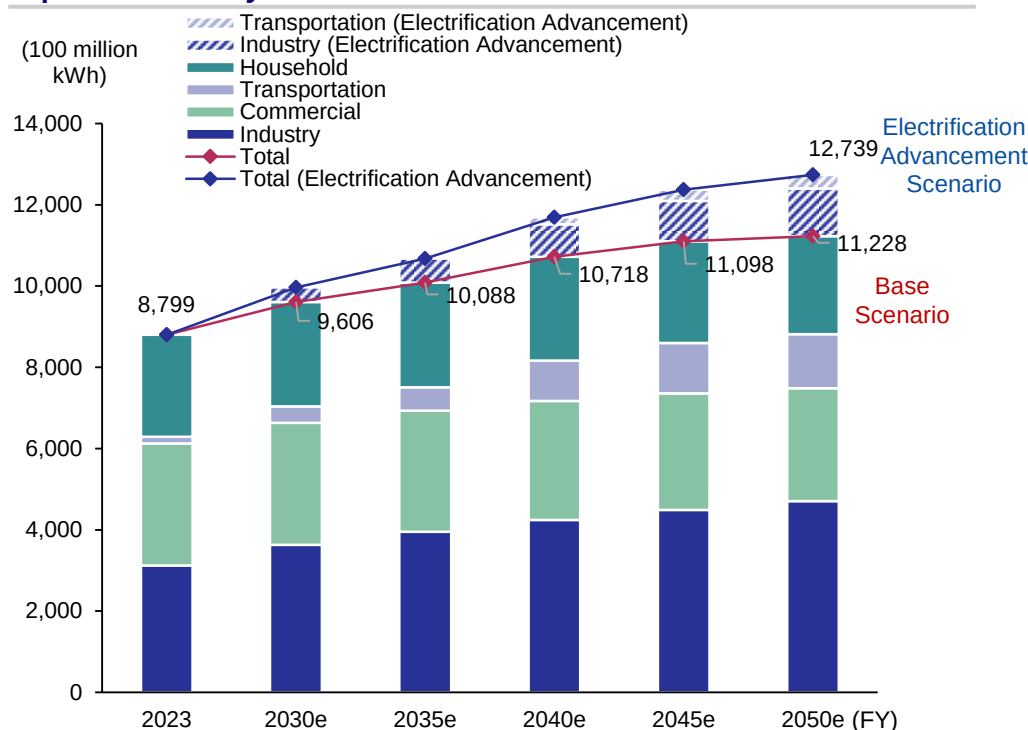


Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Japan's energy self-sufficiency rate is lower than major countries, and raising the self-sufficiency rate to ensure energy security is an urgent issue

- Electricity demand in Japan is projected to increase toward 2050 due to advances in electrification and expanded deployment of data centers
 - Estimated at approximately 1.1 trillion kWh in 2050 under the base scenario. Under the electrification advancement scenario, with expanded electrification in the industrial and transportation sectors as an increase factor, estimated at approximately 1.3 trillion kWh in 2050
- As a country with limited resources, Japan's energy self-sufficiency rate currently stands at approximately 15%, a lower level than major countries
 - According to the FY2040 energy supply and demand outlook in the 7th Strategic Energy Plan, while electricity demand will increase, the energy self-sufficiency rate is expected to rise to 27-35% through advancing expanded deployment of renewable energy and the restart of nuclear power plants

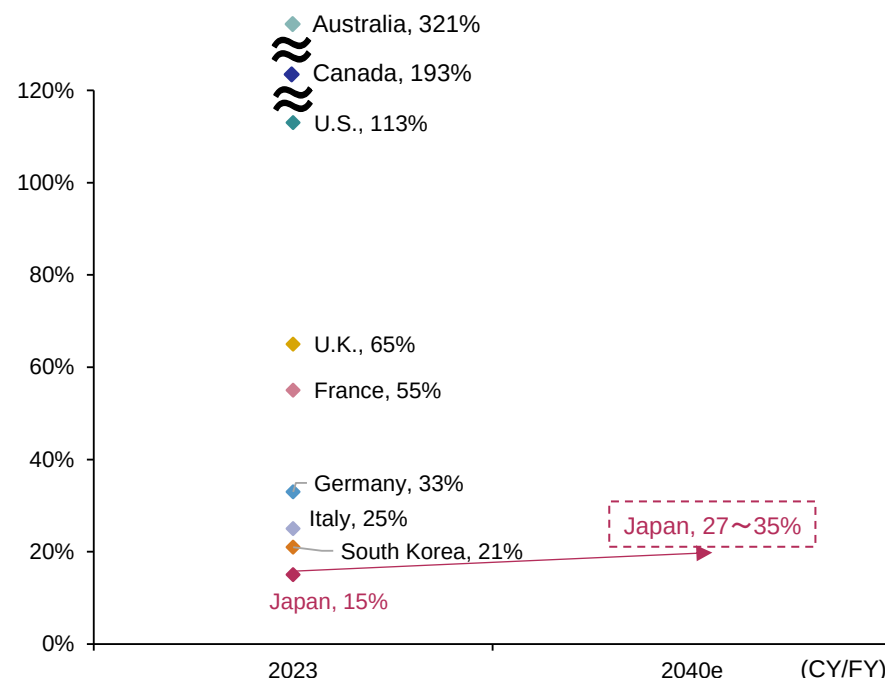
Japan's electricity demand outlook



Note: FY2030-FY2050 forecasts are by Industry Research Department, Mizuho Bank, Ltd.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics" and other materials

Outlook for Japan's energy self-sufficiency rate



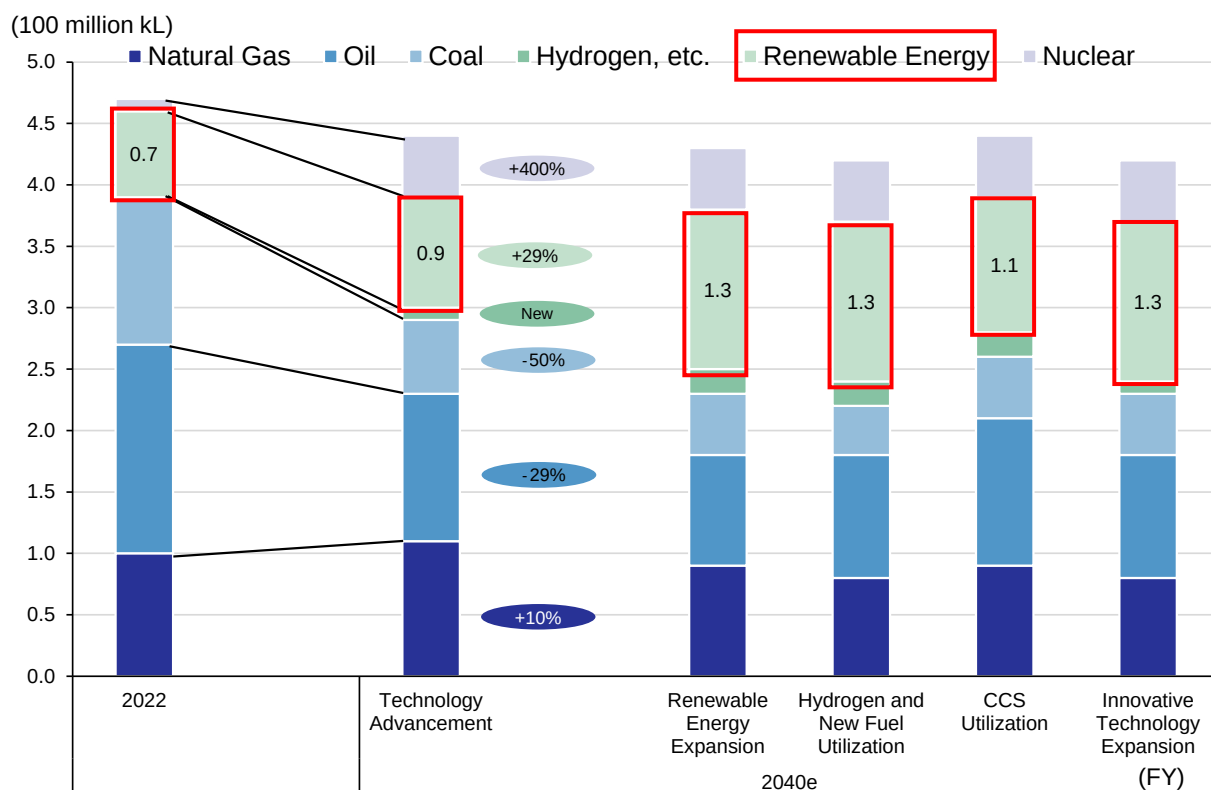
Note: FY2040 figures show the range presented in the scenario-based energy supply and demand outlook in the 7th Strategic Energy Plan. CY/FY follows each country's disclosure

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Institute of Energy Economics, Japan "IEEJ Outlook 2026" and Agency for Natural Resources and Energy "Outlook for Energy Supply and Demand in FY2040 (Related Materials)"

Renewable energy as a major power source is highly important from the perspective of ensuring energy security, and grid reinforcement is necessary for its realization

- In the FY2040 energy supply and demand outlook of the 7th Strategic Energy Plan, renewable energy as a domestically produced energy source is positioned as a major power source for enhancing energy security, and is projected to increase under all scenarios
- To realize renewable energy as a major power source, it is urgently necessary to establish a transmission and distribution business framework capable of sustainable grid investment — including maximum utilization of existing grids and the development of inter-regional interconnection lines — through Electric Power Network Optimization

Projected changes in Japan's primary energy supply



Note: Technology Advancement Scenario: A scenario in which significant cost reductions for innovative technologies do not sufficiently progress by FY2040, and deployment expansion advances mainly with existing technologies
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Outlook for Energy Supply and Demand in FY2040 (Related Materials)"

Importance of forming a wide-area transmission and distribution network

7th Strategic Energy Plan (5) Construction of Next-Generation Power Networks I. Overview

- Advancing the next-generation transformation of power networks is essential for ensuring stable power supply while promoting the decarbonization of the power system.
- To enhance resilience during natural disasters and other events and **achieve maximum utilization of renewable energy**, while **enabling timely power supply in anticipation of future electricity demand**, it is necessary to steadily advance **maximum utilization of existing grids**, as well as, based on the Master Plan for the Wide-Area Interconnected Grid formulated by the Organization for Cross-regional Coordination of Transmission Operators (OCCTO), **the development of inter-regional interconnection lines and the reinforcement of intra-regional trunk grids and other facilities.**

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "7th Strategic Energy Plan"

Grid reinforcement enables resolution of geographical gaps between renewable energy demand and supply, and temporal gaps caused by output fluctuations

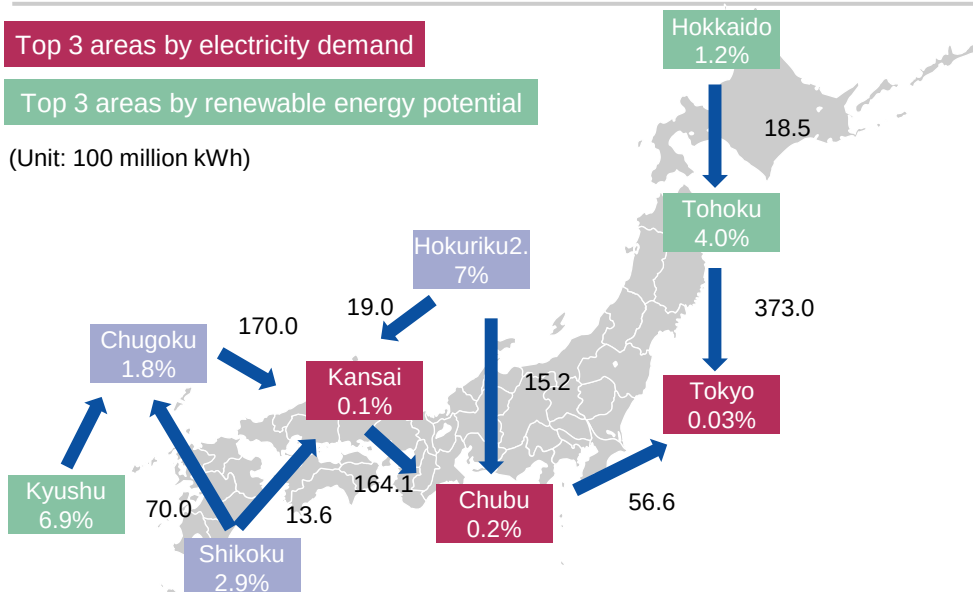
- To resolve the geographical gap between demand and supply for the expanded deployment of renewable energy, wide-area grid reinforcement is necessary, including the development of inter-regional interconnection lines for transmitting power from areas with renewable energy potential to demand areas, and the reinforcement of intra-regional trunk grids
- Based on the FY2024 actual load curve and power generation results, estimates of the FY2050 power supply and demand situation indicate that, in addition to supply shortages, supply surpluses will occur at certain supply-demand cross-sections, necessitating initiatives to increase demand such as battery charging and pumped-storage water pumping
 - Grid reinforcement is necessary in response to connections that exceed the operational capacity of existing grids, such as grid-scale storage batteries, which serve as important resources for supply-demand adjustment

Inter-regional interconnection line utilization status (FY2024) and outlook for output curtailment rate by area

Top 3 areas by electricity demand

Top 3 areas by renewable energy potential

(Unit: 100 million kWh)



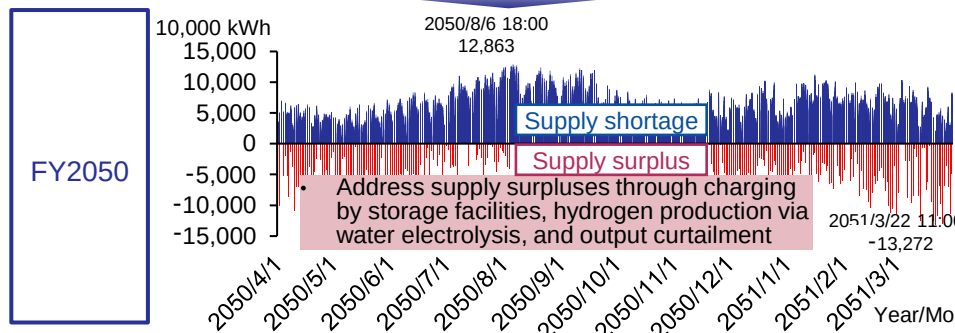
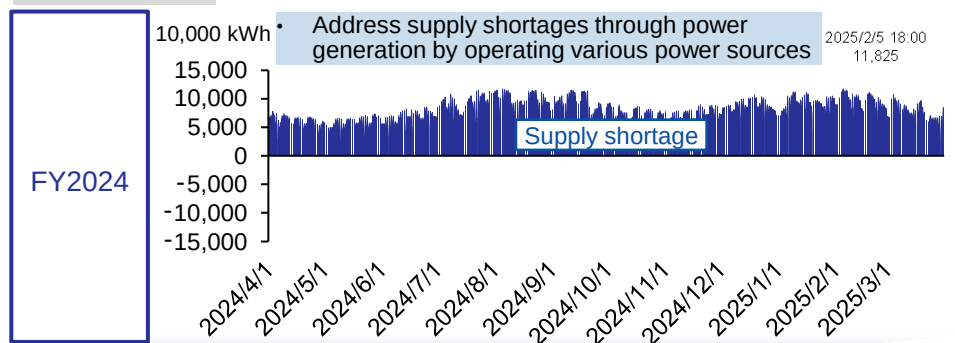
- Renewable energy output curtailment is occurring in each area, and with a view to renewable energy as a major power source, the government is considering wide-area grid reinforcement such as submarine power transmission between Hokkaido and Honshu and between Chugoku and Kyushu, as well as reinforcement of intra-regional trunk grids

Note: Output curtailment rate by area is the FY2026 outlook. Each interconnection line utilization is shown in the direction of higher utilization

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Organization for Cross-regional Coordination of Transmission Operators (OCCTO) "Overview of Electricity Supply and Demand and Power Grid - FY2024 Results", Ministry of the Environment "Survey on Potential for Introduction of Renewable Energy", and other materials

Hourly changes in power supply and demand by non-fossil power sources (image)

Electricity demand — Solar, wind, conventional hydro, geothermal, nuclear, biomass



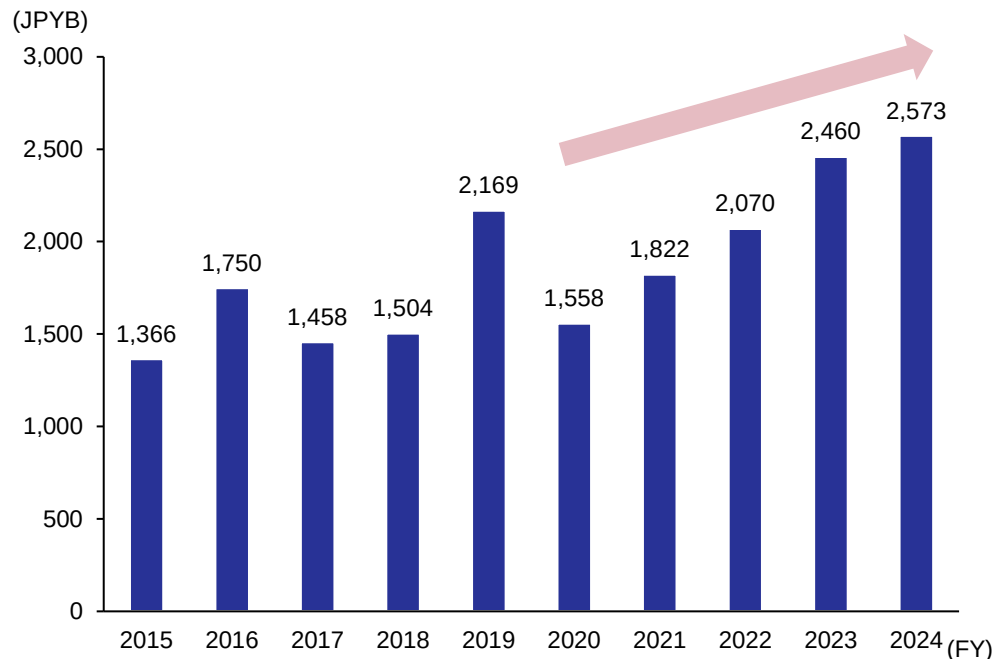
Note: FY2050 electricity demand and power generation from each power source are estimates by Industry Research Department, Mizuho Bank, Ltd.. Electricity demand and the generation portfolio of variable renewable energy reference FY2024

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by General Transmission and Distribution Utilities and the Organization for Cross-regional Coordination of Transmission Operators (OCCTO), and other materials

Development of the transmission and distribution network is essential for renewable energy deployment, but construction capacity is on a declining trend

- Transmission line construction work is increasing, and the number of high-elevation workers required as construction capacity is on a declining trend. In addition, aging is advancing, with half of substation workers in their 50s or older
- As competition for human resources, including with other industries, is intense and securing construction capacity is difficult, it is necessary to advance labor-saving and efficiency improvements by reducing manual work through the use of digital and AI technologies

Transmission line construction order results

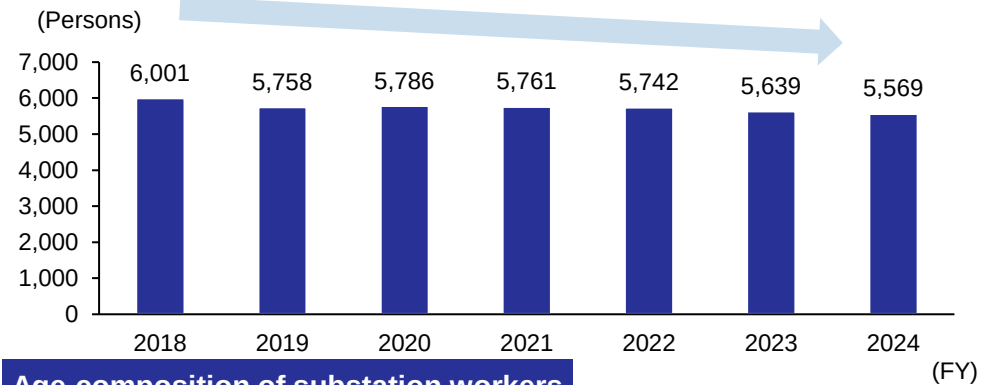


While transmission line construction volume is on an increasing trend toward expanded deployment of renewable energy and other sources, securing construction capacity in line with the increase in construction volume is a challenge

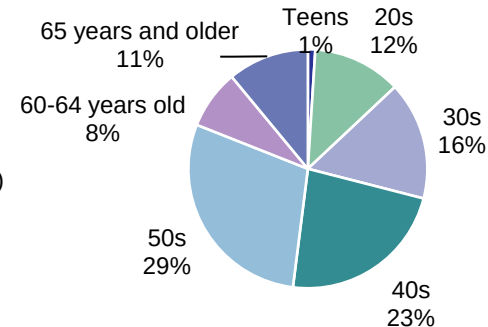
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Japan Transmission Construction and Technology Research Association "Statistical Survey"

Concerns over construction capacity shortage among transmission and distribution workers

Trend in the number of high-elevation workers



Age composition of substation workers



- Going forward, many substation facilities are expected to reach their replacement period, and currently construction volume is projected to increase due to factors such as the rise in data center connections
- Approximately half of substation workers are in their 50s or older and possess technical knowledge and experience

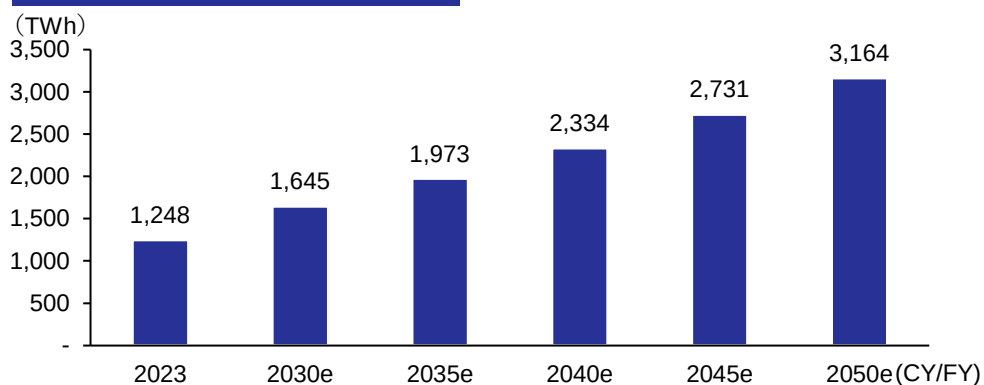
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Japan Transmission Construction and Technology Research Association "Statistical Survey" and the Transmission & Distribution Grid Council of Japan "Current Status and Challenges of Human Resources and Supply Chain in the Transmission and Distribution Business"

Addressing geographical and temporal gaps for expanded renewable energy deployment is expected to become necessary in ASEAN as well

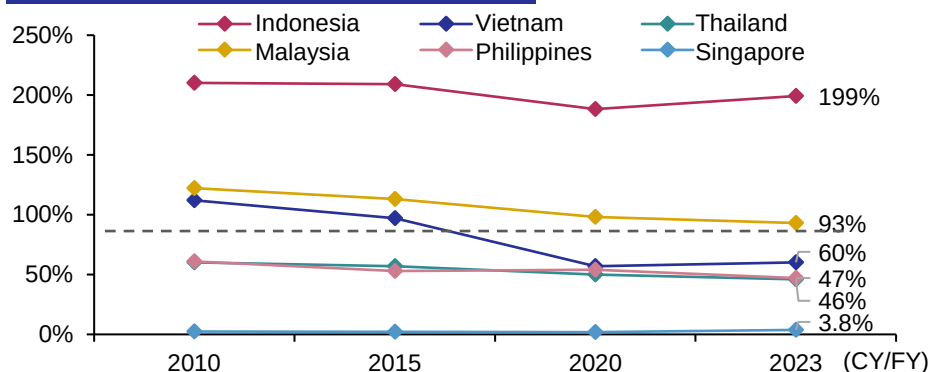
- Along with rising energy demand, the energy self-sufficiency rate in many major ASEAN countries has fallen below 100%. The importance of responding to growing electricity demand while ensuring energy security is increasing in ASEAN as well
- Major ASEAN countries plan to advance investment in transmission and distribution and electricity storage to address geographical and temporal gaps, in order to expand the deployment of renewable energy as a domestically produced energy source

Electricity demand outlook and trend in energy self-sufficiency rate in ASEAN

Electricity demand outlook



Trend in energy self-sufficiency rate



Note: CY/FY follows each country's disclosure

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Institute of Energy Economics, Japan "IEEJ Outlook 2026"

Deployment policies for renewable energy, transmission and distribution, and electricity storage in major ASEAN countries

	Renewable energy deployment policy	Deployment policy for transmission and distribution and electricity storage
Indonesia	+42.1GW (2025-2034)	- Required investment in transmission and distribution facilities during 2025-2034 is projected to be USD 35 billion - Policy to deploy +10.3GW of electricity storage facilities during the same period
Vietnam	+65.8~119.0GW (2025-2030)	- Required investment in transmission and distribution facilities by 2035 is projected to be USD 34 billion - Policy to deploy +12.4-22.3GW of electricity storage facilities during 2025-2030
Thailand	+44.0GW (2025-2037)	The PDP (Power Development Plan) 2024 (Draft) presents a proposal to deploy +13GW of electricity storage technology during 2025-2037
Malaysia	+25.9GW (2025-2040)	- Required investment in transmission and distribution facilities during 2023-2050 is projected to be USD 76 billion - Required investment in electricity storage facilities during the same period is projected to be USD 17.9 billion
Philippines	+53.5~57.6GW (2025-2040)	Policy to deploy +0.5-6.0GW of electricity storage facilities during 2025-2040
Singapore	+0.6GW or more (2025-2030)	N/A

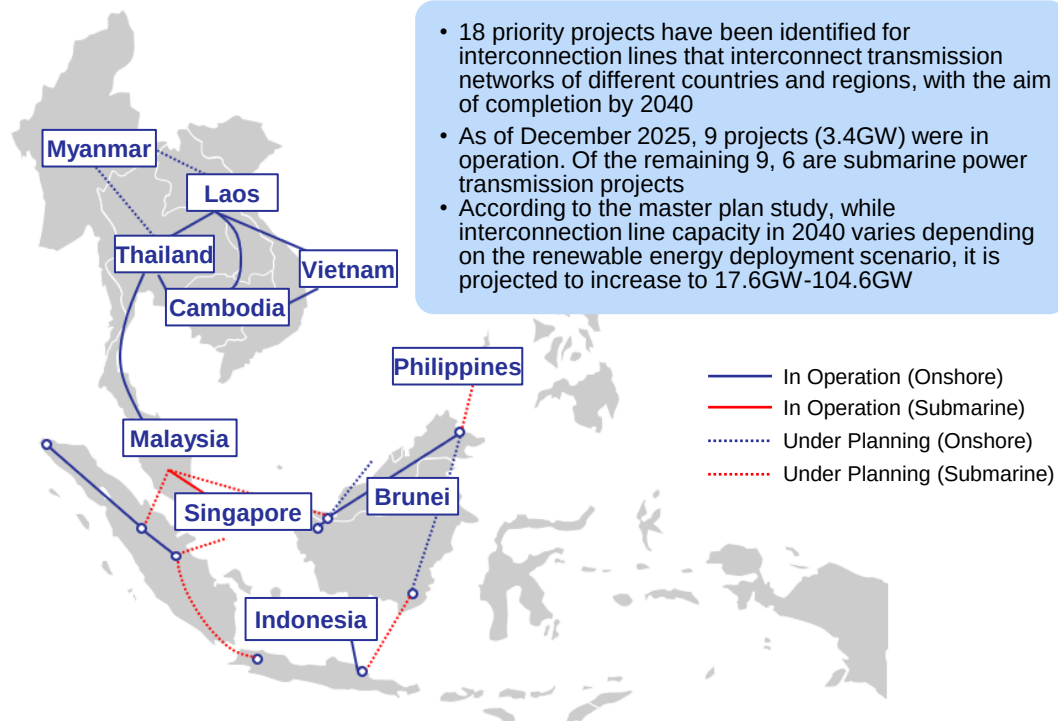
Note: Vietnam's renewable energy deployment policy figures include 6.0-17.0GW of offshore wind scheduled to commence operation during 2030-2035

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each country's government

Interest in cross-border power transmission spanning countries and regions is expanding in ASEAN from the perspective of effective utilization of renewable energy

- In ASEAN, the development of cross-border transmission networks spanning countries and regions has been promoted since 1997 as the ASEAN Power Grid (APG) with the aim of stable power supply within the region, and in recent years, interest among ASEAN countries has expanded anew from the perspective of effective utilization of renewable energy
- In the electricity policies of ASEAN countries as well, consideration of electricity import and export is expanding, and in addition to interconnection lines that interconnect transmission networks between countries and regions, examination of the development of dedicated transmission lines connecting power plants in exporting locations with transmission networks in importing locations is also accelerating
- The development of cross-border transmission networks in ASEAN has progressed centered on onshore power transmission, and going forward, the construction of more challenging submarine power transmission will be necessary

Consideration of inter-country and inter-regional interconnection lines under the ASEAN power grid (APG)



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on ACE, ASEAN Power Grid Updates 2025, ACE, Findings of ASEAN Interconnection Masterplan Study (AIMS) III Phase 1 & 2 Update, and other materials

Examples of electricity import and export consideration in major ASEAN countries

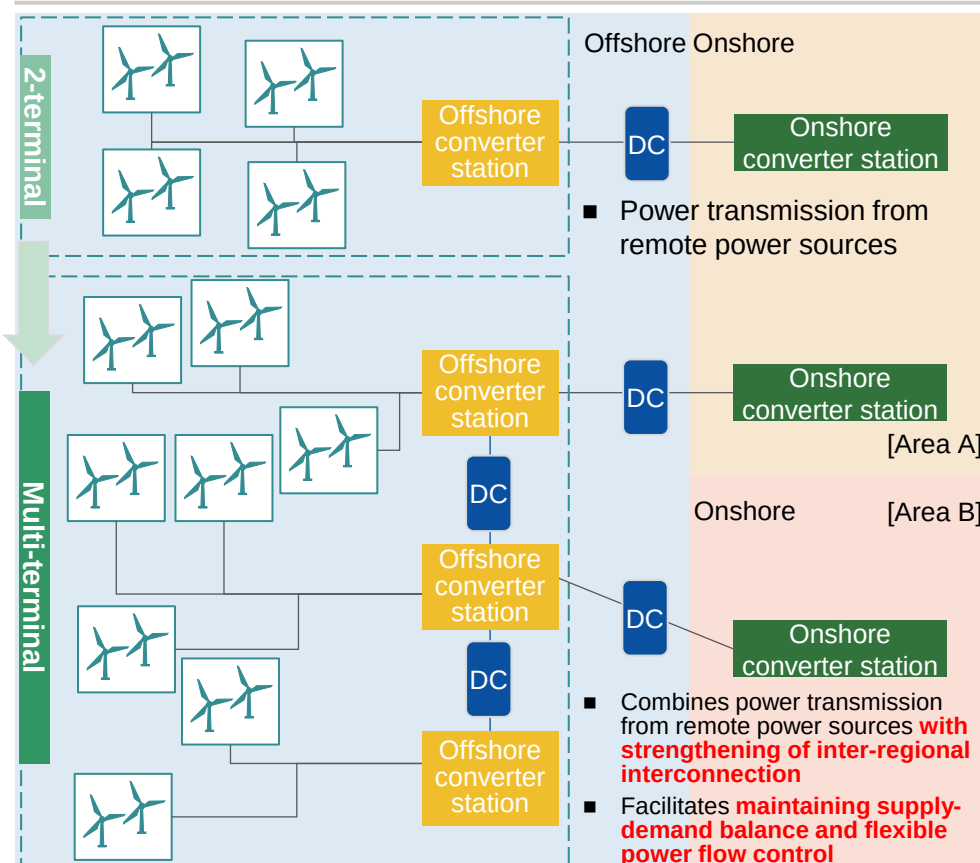
	Major examples of electricity import and export consideration
Indonesia	• Multiple electricity export projects to Singapore are under examination in the Riau Islands
Vietnam	• In the north, 9.4-12.1GW of electricity imports from Laos and China are planned by 2030 • Meanwhile, in the south, the export of 5.0-10.0GW of offshore wind power to Singapore, Malaysia, and others is planned by 2035
Thailand	• Already imports 6.2GW of electricity from Laos • The PDP (Power Development Plan) 2024 (Draft) presents a proposal to expand import volume to 10.3GW by 2037
Malaysia	• Established a cross-border power exchange for renewable electricity in April 2024 and began electricity exports to Singapore • Power transmission from Vietnam to Peninsular Malaysia is under examination
Singapore	• Targets approximately 6GW of clean electricity imports by 2035 • 11 electricity import projects (totaling 8.4GW) from Indonesia, Vietnam, Cambodia, Malaysia, and Australia are under examination

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each country's government and other materials

Advances in HVDC-related technologies enable the deployment of remote power sources such as offshore wind and the strengthening of inter-regional interconnection

- In Japan, offshore wind power plants are expected to be deployed along the coastline, and direct current transmission systems capable of long-distance transmission and multi-terminal connection of multiple power plants with the power grid and demand areas are effective for the expanded deployment of offshore wind
 - Contributes to strengthening inter-regional interconnection, maintaining supply-demand balance, and flexible power flow control. Domestic deployment around 2030 and overseas expansion are under consideration
- In HVDC-related technologies, European players leading in multi-country interconnection and direct current transmission from offshore wind have strengths, but Japanese companies also demonstrate a certain presence by winning projects globally

Construction of multi-purpose multi-terminal HVDC systems



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on NEDO published materials

Trends in HVDC-related technologies

Technology elements	Direction of technology development	Major players
Submarine cable manufacturing and Installation	■ Higher voltage ■ Cost reduction ■ Utilization of underwater drones in maintenance ■ Development of installation methods for deep-sea	Japanese ✓ Sumitomo Electric Industries ✓ Furukawa Electric
	etc.	Europe ✓ Prysmian ✓ Nexans
HVDC system	■ High voltage ■ Expansion of transmission capacity ■ Reduction of transmission losses ■ Increased compactness	Japanese ✓ Hitachi Energy ✓ Toshiba ✓ Mitsubishi Electric
	etc.	Europe and U.S. ✓ GE Vernova ✓ Siemens Energy

- European players leading in long-distance transmission network development and direct current transmission businesses from offshore wind have strengths, but Japanese companies also demonstrate a certain presence by winning projects globally

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on published materials

Initiatives leveraging technology in transmission and distribution to achieve early expansion of transmission capacity and labor-saving and efficiency improvements are accelerating

- In the U.S., given that the construction of new transmission networks takes time, the deployment and consideration of GETs (Grid-Enhancing Technologies) for the effective utilization of existing transmission networks is accelerating
- In Japan as well, in addition to consideration of capacity expansion of existing transmission networks, initiatives are progressing to accelerate grid connection through AI-based simulation in grid planning, and to achieve labor-saving and efficiency improvements by utilizing drones and other technologies in O&M

Overview of GETs (grid-enhancing technologies)

	Overview	Major effects
Advanced conductor	■ Capacity expansion compared to conventional type, reduction of transmission losses ⇒ Replacement with advanced transmission lines	Capacity increase
Dynamic line rating	■ Real-time measurement of temperature, wind speed, and other parameters to calculate transmission capacity and improve transmission efficiency ⇒ Deployment of IoT sensors and software to monitor the status of transmission lines	Capacity increase Cost suppression
Topology optimization	■ Optimization of combinations of transmission lines and switchgear to avoid congestion ⇒ Software deployment	Capacity increase Cost suppression Reliability improvement
Advanced power flow control	■ Dynamically shifting power flow on transmission lines to avoid congestion ⇒ Installation of power flow control devices	Capacity increase Cost suppression

FERC (Federal Energy Regulatory Commission)

- In May 2024, through Order 1920, RTOs/ISOs such as PJM were required to examine the deployment of technologies, including some GETs
- Both the construction of new transmission networks and the renewal of existing transmission networks are subject to the rule

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on DOE and FERC materials

Major initiatives leveraging digital and AI technologies for labor-saving and efficiency improvements in transmission and distribution

Examples of initiatives	Overview and effects
Grid planning leveraging AI	■ Accelerate simulations related to grid connection of renewable energy and other sources by leveraging AI ⇒ Accelerate approval of transmission and distribution network reinforcement and new grid connections
Advanced asset management	■ Quantify and visualize the failure probability due to aging of transmission and distribution facilities and the impact of failures ⇒ Contribute to efficient facility risk management and facility renewal planning
Utilization of drones	■ Replacement of high-elevation work and utilization for patrol inspections in remote areas such as mountainous regions ⇒ Reduction of workload, improvement of safety, and early identification of disaster conditions
Diagnosis leveraging AI imagery and satellite imagery	■ Identification of facility conditions independent of skill level and early identification of disaster conditions during disasters ⇒ Optimization of facility repair timing, advanced identification of deterioration and abnormalities, and identification of patrol locations
Digitalization of substations	■ Highly accurate and real-time information collection on the condition of substation facilities through the installation of equipment ⇒ Advanced facility deterioration analysis and abnormality identification, reduction of on-site visits, and reduction of construction labor burden

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on various published materials and the Transmission & Distribution Grid Council of Japan "4th Transmission and Distribution Grid Investment and Operational Efficiency Committee Material 1: On Initiatives for Advanced Maintenance by General Transmission and Distribution Utilities"

Japan possesses strengths in enhancing the certainty of stable power supply and a track record of horizontal expansion from domestic and overseas submarine power transmission business experience

- As an island nation under geographical conditions where it cannot receive power supply from other countries, Japan has cultivated strengths in planning capabilities, the ability to build sophisticated grid systems and internal and external coordination frameworks, and supply-demand adjustment capabilities to enhance the certainty of stable power supply. Leveraging its experience in domestic and overseas submarine power transmission business, Japan has also expanded participation in submarine power transmission projects, mainly in Europe
- Japanese power companies are presumed to have gained a certain level of trust through ASEAN transmission and distribution consulting projects and feasibility study (FS) projects, among others

Japan's strengths in electric power network optimization in the transmission and distribution business

Europe's power network

- Multi-country interconnection has been advanced from earlier on, forming a large-scale synchronous grid across Europe as a whole
- Power sources not only within each country but also from other countries can be utilized, forming a structure in which stable power supply is pursued across Europe as a whole



Japan's power network

To enhance the certainty of stable power supply in light of disasters and other factors

- ✓ Planning capabilities
- ✓ Ability to build sophisticated grid systems and coordination frameworks
- ✓ Supply-demand adjustment capabilities

- Planning capabilities for resilience enhancement, including the redundancy of transmission lines and substation facilities, in light of Japan being a disaster-prone country
- The control equipment and system construction deployed to minimize the impact of power outages are sophisticated, and internal and external coordination frameworks have been established for early restoration during power outages and other events
- Wide-area supply-demand adjustment capabilities, also leveraging inter-regional interconnection lines, that enable both steady deployment of renewable energy and stable power supply despite being an island nation
- Leveraging experience in domestic and overseas submarine power transmission business, participation in other submarine power transmission projects has been expanded

Track Record of Horizontal Expansion of Submarine Power Transmission Business

While maintaining its strengths in independently enhancing the certainty of stable supply despite being an island nation, Japan, as a country facing advanced challenges, will undertake labor-saving and efficiency improvements in transmission and distribution in anticipation of worsening construction labor shortages going forward

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In ASEAN, where energy integration on the scale of the EU is difficult to envisage, the construction of a wide-area transmission and distribution network including submarine power transmission is an area where the domestic and overseas business experience of Japanese companies can be leveraged

Engagement of Japanese power companies in ASEAN transmission and distribution business

Past transmission and distribution-related projects/ consulting services in ASEAN

Power company	Area collaboration partner	Project overview
TEPCO Group	Singapore SP Group	✓ Consulting services related to an underground substation construction project
TEPCO PG Chubu Electric Power	Singapore ICMG	✓ Established an operating company that develops and operates transmission and distribution business and next-generation infrastructure business, mainly in the Asian region
Kansai Electric Power Group J-POWER	Indonesia PLN	✓ Consulting related to the Java-Sumatra interconnection transmission line project

Global south future-oriented co-creation business subsidy (FY2024 supplementary budget)

Power company	Area	Project overview
Kansai Electric Power Kansai Transmission and Distribution	Indonesia	✓ Survey project (FS project) toward the realization of inter-island interconnection lines through utilization of private capital
TEPCO PG	Singapore Indonesia	✓ Submarine transmission line survey project (FS project) for importing low-carbon power sources from neighboring countries
Chubu Electric Power Grid	Indonesia	✓ Demonstration project for advanced maintenance of transmission and substation facilities (demonstration project)

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each company

Japanese power companies have participated in submarine power transmission business mainly in Europe, extending operational experience and technical expertise

- Major Japanese power companies have implemented horizontal expansion leveraging their domestic and overseas submarine power transmission experience. In some submarine direct current transmission projects, they have participated from the development stage
 - By participating in submarine direct current transmission business in Europe and other regions leading in offshore wind power generation, Japanese power companies have gained operational experience and enhanced technical expertise in areas such as, equipment specification examination, construction progress management, and maintenance of transmission and substation facilities, while securing stable revenue

Participation status of Japanese power companies in overseas power transmission business

Company name	Area	Project overview	Participation date	Commercial operation date (facility transfer date)	Partners (Note)
TEPCO PG	U.K.	✓ Submarine power transmission business for the Triton Knoll offshore wind power plant (capacity: 870MW, submarine transmission: 50km, underground transmission: 57km)	2021 Preferred bidder status	2023 Acquisition of ownership and operating rights	The Company: 20%, Equitix: 80%
TEPCO PG, Kansai Electric Power	U.K. Germany	✓ NeuConnect UK-Germany interconnection project (capacity: 1,400MW, submarine transmission: 706km, onshore transmission: 14km, ultra-high voltage direct current interconnection transmission system)	Kansai Electric Power: 2018 TEPCO PG: 2022	Scheduled for 2028	TEPCO PG: 2% (scheduled to become 6.5% upon exercise of capital increase option), Kansai Electric Power: 18.3%, Meridiam: 53.5%, Allianz Capital Partners: 26.2%
Chubu Electric Power	Germany	✓ Submarine power transmission business for the BorWin1, BorWin2, DolWin2, and HelWin2 offshore wind power plants (total capacity: 2,810MW, total submarine transmission: 380km, total onshore transmission: 285km)	2017	2015, 2017	The Company: 12.2%, Copenhagen Infrastructure Partners: 25%, Mitsubishi HC Capital: 11.8%, TenneT: 51%
	U.K.	✓ Submarine power transmission business for the Walney Extension offshore wind power plant (capacity: 660MW, submarine transmission: 75km, onshore transmission: 5km)	2019	2018	The Company: 20%, BlackRock: 51%, HICL Infrastructure: 29%
	U.K.	✓ Submarine power transmission business for the Hornsea One offshore wind power plant (capacity: 1,218MW, submarine transmission: 145km, onshore transmission: 38km)	2020	2019	The Company: 49%, BlackRock: 20%, Mitsubishi HC Capital: 31%
Kyushu Electric Power Group	UAE	✓ Ultra-high voltage direct current transmission facilities from the mainland to oil and gas production bases	2021	2025	The Company Group, KEPCO, EDF, ADNOC, TAQA
	U.K.	✓ Submarine power transmission business for the Seagreen Phase 1 offshore wind power plant (capacity: 1,080MW, submarine and underground transmission: 84km)	2023	2025	The Company Group: 50%, Equitix: 50%
	U.K.	✓ Submarine power transmission business for the Dogger Bank A offshore wind power plant (capacity: 1,200MW, submarine and underground transmission: 206.5km)	2024	TBD	The Company Group, Equitix

Japanese power companies, leveraging their domestic and overseas submarine power transmission business experience, have implemented horizontal expansion and extended operational experience and various technical expertise

Note: In the case of investment by subsidiary group companies or funds, the representative company is shown

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each company

Electric power network optimization contributes to building the foundation for Japan's GX and DX and strengthening energy security within ASEAN

- In response to the increase in transmission and distribution-related construction volume, investments in labor-saving and efficiency improvements in transmission and distribution leveraging digital and AI technologies will build a sustainable framework for the domestic transmission and distribution business, underpinning the promotion of GX and DX, set as national policies, as foundational infrastructure
- In addition to pursuing growth through participation in ASEAN cross-border power transmission business, the construction of a wide-area transmission and distribution network curbs the decline in regional energy self-sufficiency

Significance of engaging in electric power network optimization and social impact

	Current situation	Significance of engaging in promising domains	Social impact
Labor-saving and efficiency improvements in transmission and distribution leveraging digital and AI technologies	■ As the transmission and distribution industry faces construction labor shortages, grid connection needs for renewable energy, storage batteries, data centers, and others are increasing, with construction volume on an increasing trend ■ Under the revenue cap system, digitalization, DX, and efficiency are being promoted as next-generation investments, but their share of next-generation investment costs (approximately 2% of total costs) is approximately 11%	■ In response to the increase in construction volume noted on the left, labor-saving and efficiency leveraging digital and AI technologies are being promoted ■ Build a transmission and distribution business framework capable of sustainably implementing necessary grid investments	■ Underpin the promotion of GX and DX, which Japan has set as national policies, as foundational infrastructure ■ Contribute to maintaining and strengthening Japan's industrial competitiveness
While the upside in profitability in the transmission and distribution business is limited, promoting labor-saving and efficiency in the domestic transmission and distribution business will achieve cost reduction <defense>			
ASEAN cross-border power transmission	■ The development of cross-border transmission networks in ASEAN has made a certain degree of progress, mainly in onshore power transmission ■ From the perspective of effective utilization of renewable energy, in addition to interconnection lines that interconnect transmission networks between countries and regions, examination of the development of dedicated transmission lines connecting power plants in exporting locations with transmission networks in importing locations is progressing	■ Utilization of planning capabilities in the transmission and distribution domain and submarine power transmission business experience in Japan, Europe, and other regions ■ Securing stable income by participating in phases according to risk tolerance ■ In electricity import and export projects, improvement in profitability through integrated development with renewable energy is also expected	■ While needs for labor-saving and efficiency improvements are currently limited, the development of ASEAN cross-border power transmission will build a wide-area transmission and distribution network ■ Curb the decline in energy self-sufficiency within ASEAN through effective utilization of renewable energy
Envisage growth by expanding non-wheeling revenue through overseas deployment of power transmission business <offense>			

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

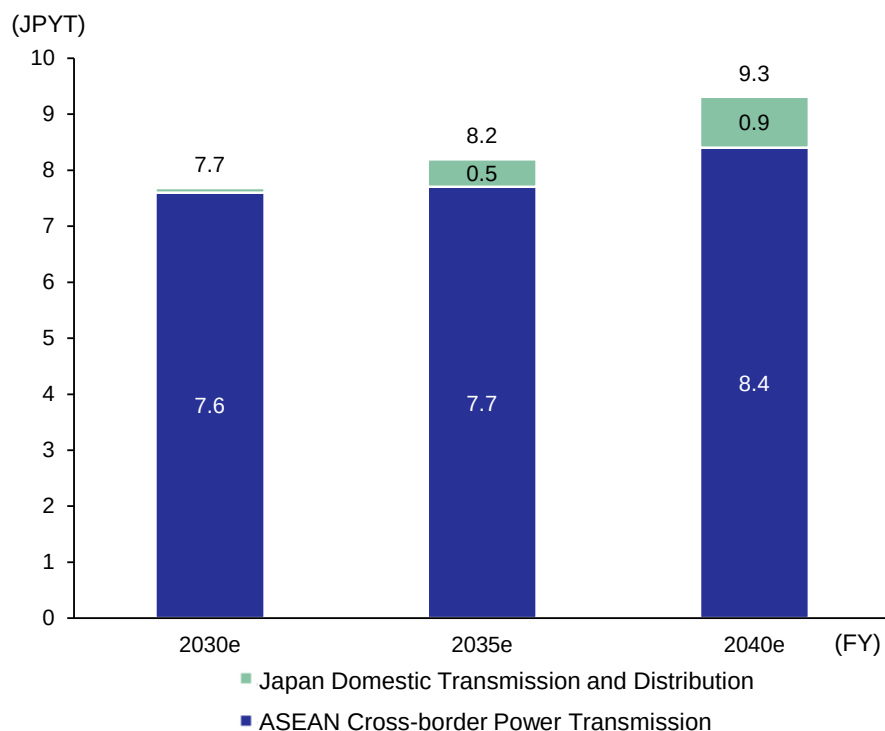
Market expansion for electric power network optimization is expected in Japan and ASEAN

- The market size of Japan's transmission and distribution business (revenue of Japan's transmission and distribution companies) is projected to increase to JPYT 8.4 in FY2040, with the increase in wheeling electricity including renewable energy, on the premise that electricity demand will increase and inter-regional interconnection lines and other infrastructure will be developed
- In ASEAN as well, needs for the construction of wide-area transmission networks are increasing, and the development of cross-border power transmission, including submarine power transmission, is progressing. The expansion of cross-border power transmission capacity will accelerate in earnest from FY2035 onward, and opportunities for participation in cross-border power transmission business are expected to expand

Approach to the market outlook for electric power network optimization

Business area	Approach to market outlook
[Domestic transmission and distribution business] Total	■ On the premise that electricity demand in Japan will increase and inter-regional interconnection lines and other infrastructure will be developed, the overall market size of transmission and distribution will expand as electricity volume, including renewable energy, increases through grid investment ■ The share of renewable energy in the power mix is projected to increase from 23% in 2023 to 45% in 2040
Participation in ASEAN cross-border power transmission business	■ The expansion of cross-border power transmission capacity will accelerate in earnest from FY2035 onward, projected to increase from 11GW in 2025 to 57GW in 2040 ■ Revenue in the cross-border power transmission business will increase along with capacity expansion (if Japanese transmission and distribution equipment manufacturers are selected as suppliers of HVDC systems, the market size for Japanese industry will further expand)

Market size outlook for electric power network optimization (domestic transmission and distribution + ASEAN cross-border power transmission)



Note: The market size for Japan domestic transmission and distribution refers to the revenue of Japan's transmission and distribution companies

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

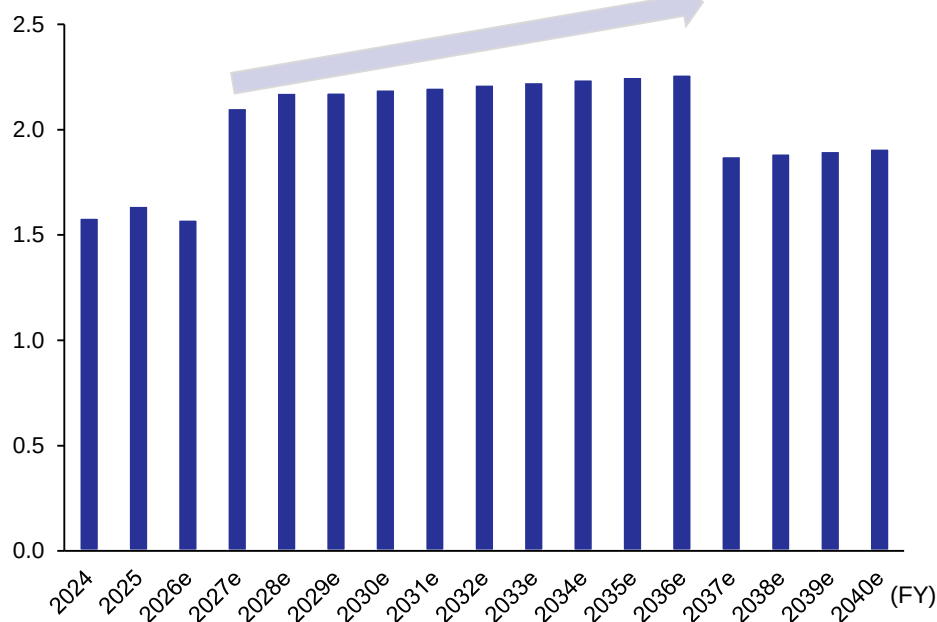
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Realization of renewable energy as a major power source is expected through advancing sustainable grid investment

- On the premise that labor-saving and efficiency improvements in the transmission and distribution domain will advance, the required investment amount for the entire domestic transmission and distribution in Japan is estimated
 - From FY2027 onward, investment in inter-regional interconnection lines and others will increase, and the investment amount is projected to increase compared to previous levels
- Through necessary transmission and distribution investments, the steady expansion of renewable energy deployment is expected to progress toward the realization of carbon neutrality by 2050
 - Realizing renewable energy as a major power source will help ensure energy security through fuel cost reduction, CO₂ reduction, and resilience improvement via inter-regional interconnection, among others

Outlook for domestic transmission and distribution investment amount

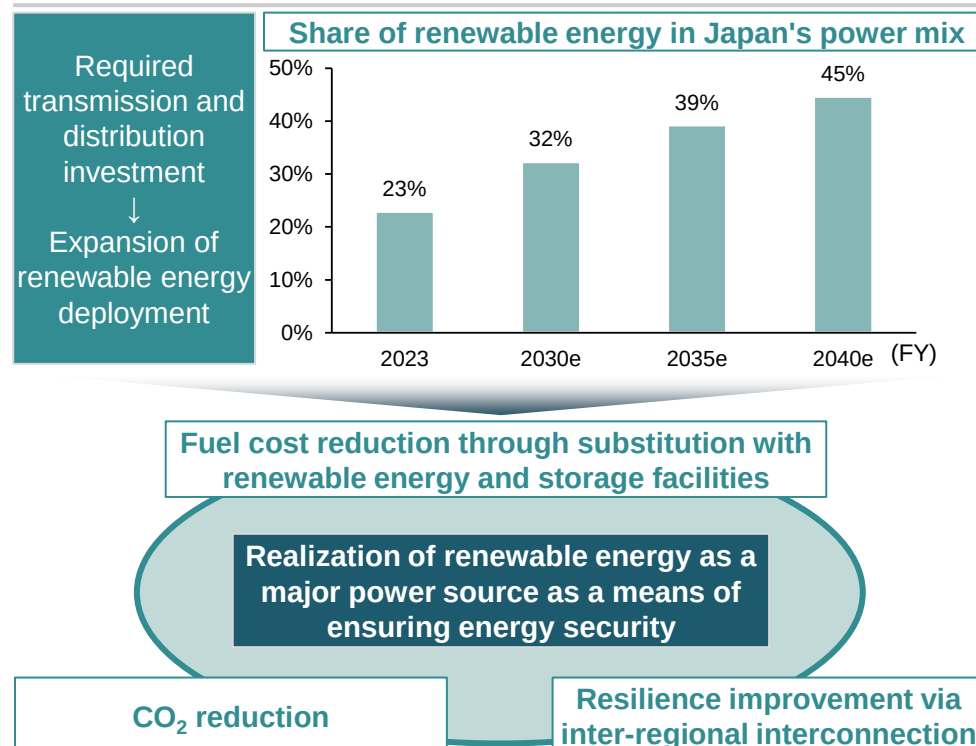
(JPYT) In addition to facility renewal, investment related to facility expansion such as inter-regional interconnection lines will increase



Note: Figures through FY2025 are based on business plans published by each company. From FY2026 onward, figures are forecasts by Industry Research Department, Mizuho Bank, Ltd.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each company and other materials

Realization of renewable energy as a major power source premised on transmission and distribution investment

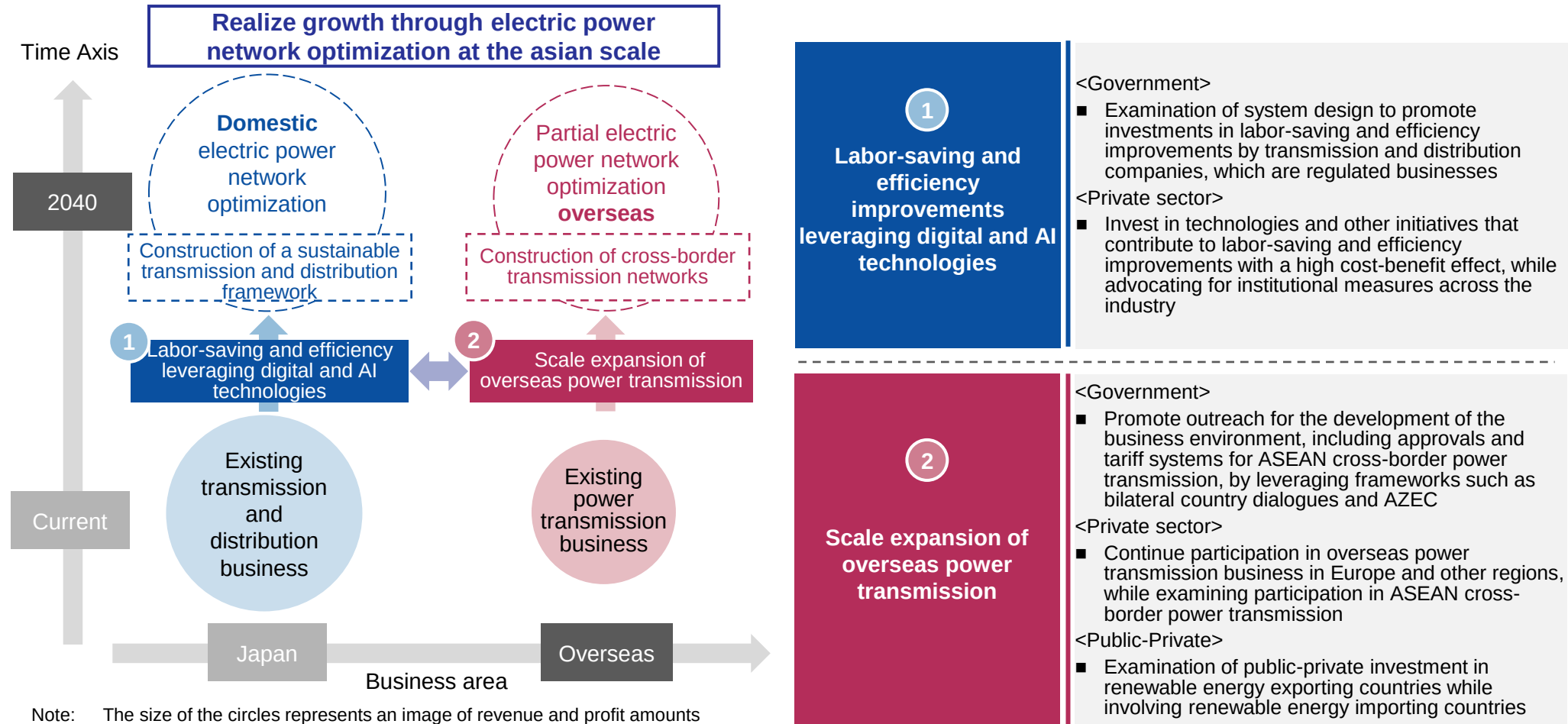


Note: FY2030-FY2040 forecasts are by Industry Research Department, Mizuho Bank, Ltd.
Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on Agency for Natural Resources and Energy "Comprehensive Energy Statistics" and other materials

Advance labor-saving and efficiency investments as a foundation while expanding the scope to electric power network optimization not only domestically but also overseas

- By advancing investments in labor-saving and efficiency improvements while advocating for institutional measures industry-wide, a transmission and distribution business framework capable of sustainable grid investment will be established
- As part of the overseas deployment of power transmission business, examining participation in cross-border power transmission business is also an option in ASEAN, where needs for the construction of wide-area power grids are increasing. The scope will be expanded to partial Electric Power Network Optimization through resolving the temporal and geographical gaps in renewable energy in ASEAN

Strategic direction toward realizing electric power network optimization

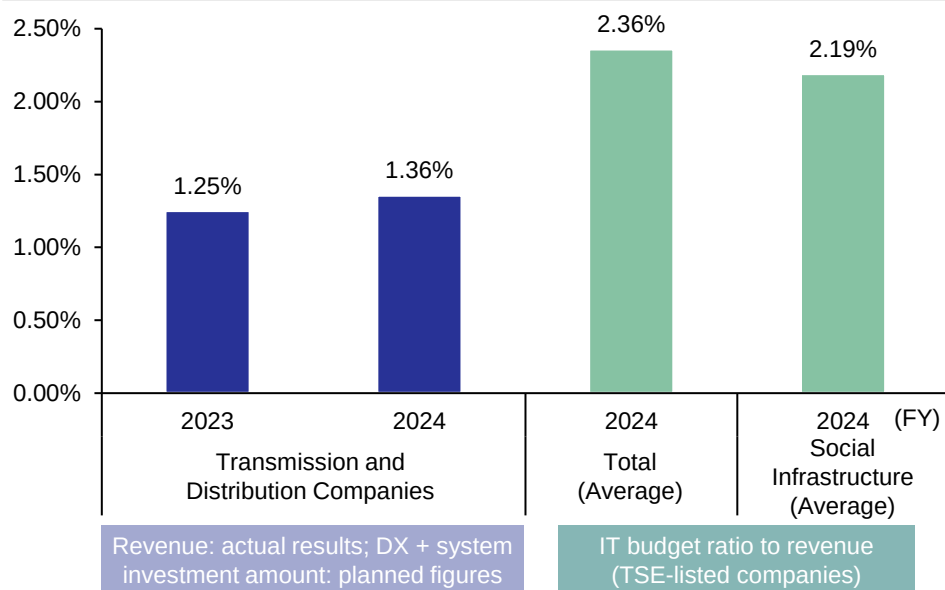


Note: The size of the circles represents an image of revenue and profit amounts
 Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Development of the business environment for digital investment contributing to labor-saving and efficiency, as well as addressing various challenges in ASEAN cross-border power transmission, are necessary

- The ratio of DX and system investment to revenue at domestic transmission and distribution companies is currently approximately 1.3-1.4%, lower than the average IT budget ratio to revenue for all TSE-listed companies in Japan (including equivalent companies) and for the social infrastructure sector. Institutional factors specific to transmission and distribution are presumed to be one of the underlying reasons
- For the realization of ASEAN cross-border power transmission, responses are required to the following challenges: (1) regulations and systems related to cross-border submarine power transmission are not yet developed, (2) experience in the development and operation of submarine direct current transmission is limited, and (3) securing investment funds for cross-border submarine power transmission projects is necessary

Comparison of IT budget ratio to revenue



Factors hindering investment progress

- The system is designed such that the efficiency improvement incentive through DX and other measures is limited to the 5-year regulatory period
- For next-generation investments including DX, it is possible to factor in costs exceeding actual results as upfront investment, but evaluation is conducted on a project-by-project basis, and even if there are technologies with high cost-effectiveness, it is difficult to flexibly revise investment content during the period

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on materials published by each company and the Japan Users Association of Information Systems "Corporate IT Trend Survey Report 2025"

Key challenges toward realizing cross-border power transmission in ASEAN

I. Regulations and systems concerning cross-border submarine power transmission are necessary

- ✓ Regulations and systems concerning power transmission (approvals for power transmission business, wheeling tariff design, availability of third-party use of transmission networks, etc.) differ by country
- ✓ Coordination of regulations and systems among relevant countries implementing cross-border submarine power transmission is necessary

II. Limited experience of ASEAN companies in the development and operation of submarine direct current transmission

- ✓ Cross-border power transmission deployed in ASEAN to date has been mainly onshore projects
- ✓ Future development plans include submarine direct current transmission, which represents a new endeavor for many ASEAN companies

III. Securing funds for cross-border power transmission project investment is necessary

- ✓ While reinforcement of domestic transmission and distribution facilities is necessary in each ASEAN country, there are also cross-border power transmission projects that require substantial investment funds
- ✓ While utilization of private and international funds is also an option, business models and investment recovery mechanisms to attract investment are currently underdeveloped

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Build a sustainable framework for electric power network optimization through labor-saving and efficiency investments via coordination and competition within the industry

- The transmission and distribution industry as a whole will advocate to the government for rulemaking that contributes to promoting digital and AI investment
- While there are areas where each company will jointly undertake labor-saving and efficiency investments through coordination, it is also necessary to differentiate in competitive areas where individual companies proactively advance technology development and platform construction and sell externally

Promotion of labor-saving investment in the transmission and distribution domain through coordination and competition

Initiatives by the transmission and distribution industry as a whole

Advocate to the government for strengthening economic incentives for digital and AI investment under the revenue cap system, and for an approach to the assessment of next-generation investments that enables flexible revision of investment content

Direction of investments in labor-saving and efficiency improvements by transmission and distribution companies (assumed)

Coordination area

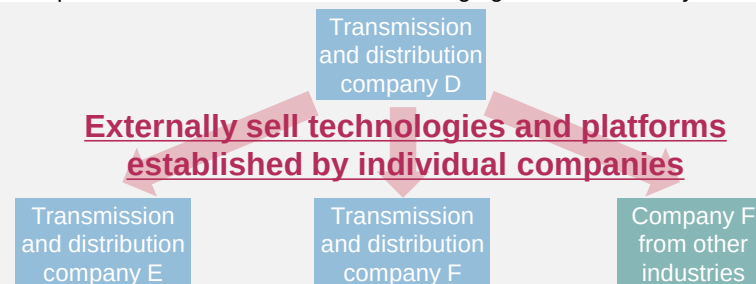
- Development of communication environments and construction of drone flight routes toward advancing construction and O&M operations of transmission, substation, and distribution facilities leveraging drones
- Sharing of facility deterioration images (training data) obtained during patrol inspections
- Development of AI image analysis systems that determine landslide and inundation areas from satellite imagery, and development of satellite utilization systems for viewing patrol areas



Technology development involving transmission and distribution companies or other industries as a coordination area

Competitive area

- Streamlining of operational workflows from planning to construction by leveraging AI
- Shortening grid-connection review times through AI-based simulation during examination of grid connection
- Development of a platform that enables data connection and integrated operation and control with other infrastructure facilities such as DER (Note), public transportation, telecommunications, water supply, and real estate
- Development of new business models leveraging various electricity data



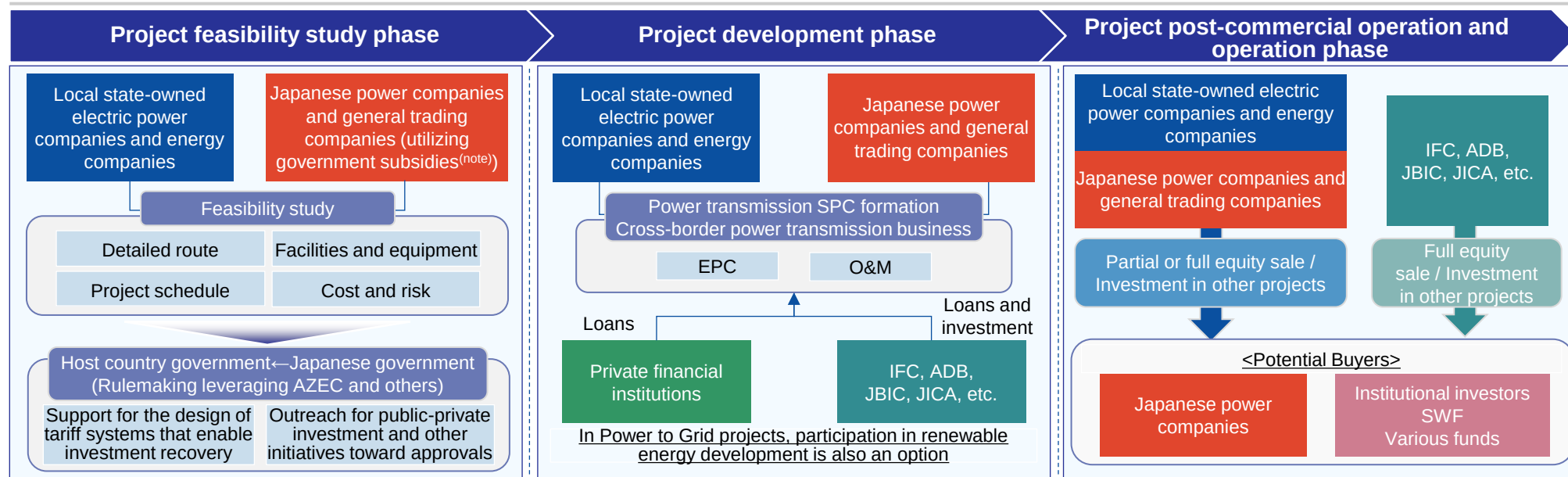
Note: Abbreviation for Distributed Energy Resources

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd. based on the Transmission & Distribution Grid Council of Japan "4th Transmission and Distribution Grid Investment and Operational Efficiency Committee Material 1: On Initiatives for Advanced Maintenance by General Transmission and Distribution Utilities"

For participation in ASEAN cross-border power transmission, public-private engagement from the business environment development stage is necessary

- For participation in ASEAN cross-border power transmission business, public-private engagement from the business environment development stage is important
 - In addition to power transmission business leveraging the business experience of Japanese companies, benefits to Japanese industry are expected through the construction of the HVDC value chain and participation in adjacent businesses. By contributing to the effective utilization of renewable energy in ASEAN, Japan can also advance the AZEC (Asia Zero Emission Community) initiative

Direction of alliances in each phase of ASEAN cross-border power transmission



Japan's objectives

- ✓ Engage in a public-private manner from the business environment development stage to secure project predictability and build competitive advantages over other countries
- ✓ Expand business opportunities for Japanese industry through the construction of a Japan-originated HVDC value chain in ASEAN

- ✓ Project formation leveraging business experience in Europe and other regions, involving not only Japanese power companies but also HVDC-related companies
- ✓ Improvement of business viability beyond power transmission business through participation in adjacent businesses such as renewable energy development

- ✓ Early recovery through sale to infrastructure funds and others by ensuring flexibility of equity sale
- ✓ Creation of participation opportunities according to the risk tolerance of business operators

Not only does this present business opportunities leveraging the business experience and technologies of Japanese companies, but Japan also contributes to the promotion of the AZEC initiative by helping ASEAN effectively utilize renewable energy

Note: Representative examples of existing initiatives include the Global South Future-oriented Co-creation Business Subsidy and the Feasibility Study Subsidy for Overseas Deployment of Quality Infrastructure

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

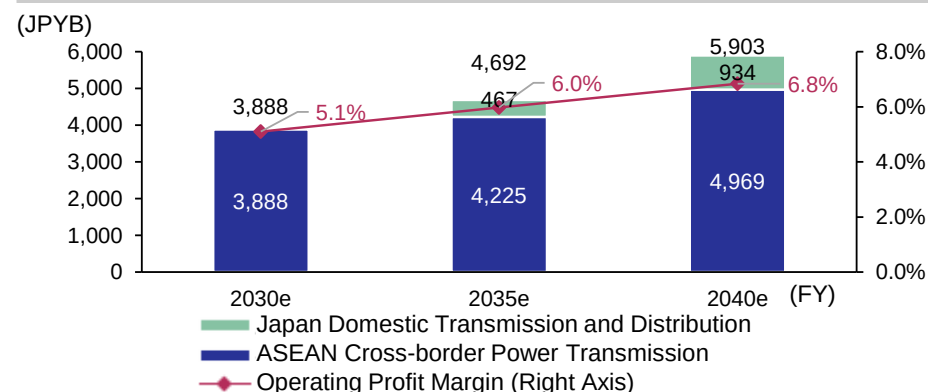
Electric power network optimization presents an attractive business opportunity from the perspectives of stable revenue and secondary effects brought about both domestically and overseas

- Based on the assumption that approximately JPYT 37 in investment will be implemented for Electric Power Network Optimization during FY2025-FY2040, operating profit in each area is estimated
 - Both operating profit amount and profit margin are expected to increase. While ROA will temporarily decline due to concentrated investment in domestic grids and ASEAN cross-border power transmission through FY2035, ROA is projected to reach a level exceeding FY2030 by FY2040
- Electric Power Network Optimization is an attractive Promising Domain not only for the stable revenue of the transmission and distribution business, but also from the perspectives of social benefits brought about by the realization of renewable energy as a major power source and the business opportunities beyond power transmission business in ASEAN

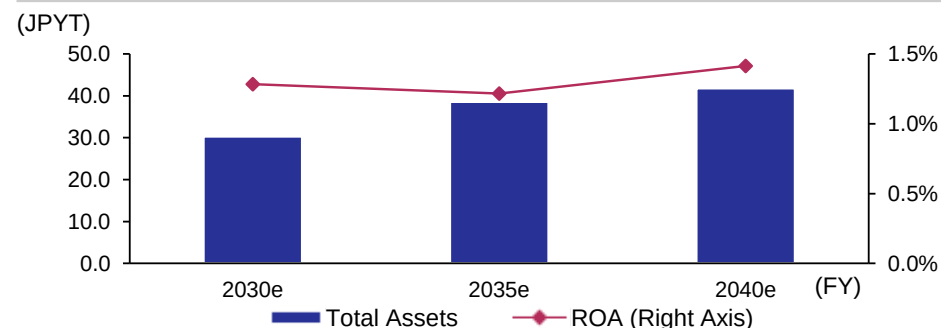
Approach to operating profit amount for electric power network optimization

Business area	Approach to operating profit amount
[Domestic transmission and Distribution business] Total	■ On the premise that certain incentives will be provided for investments contributing to labor-saving and efficiency improvements leveraging digital and AI technologies ■ As a result of continued investment, certain cost reduction effects will occur, and the operating profit margin of transmission and distribution companies is assumed to slightly increase through FY2040 By enabling sustainable grid investment, renewable energy as a major power source is realized, and social benefits such as fuel cost reduction, CO₂ reduction, and resilience improvement via inter-regional interconnection are also expected
Participation In ASEAN cross-border power transmission business	■ In submarine power transmission projects, which involve high technical difficulty and large investment amounts, business participation opportunities for foreign capital and private enterprises are expected to emerge ■ Through public-private business environment development and business development support, it is assumed that Japanese companies can be involved in 10GW out of the 20GW of submarine power transmission projects expected to be developed going forward In addition to upside from adjacent businesses such as renewable energy development linked to the power transmission business, profitability expansion of transmission and distribution equipment manufacturers is also expected from the perspective of constructing the HVDC value chain in ASEAN

Operating profit outlook for electric power network optimization (domestic transmission and distribution + ASEAN cross-border power transmission)



Outlook for ROA (operating profit / total assets) for electric power network optimization



Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

Source: Compiled by Industry Research Department, Mizuho Bank, Ltd.

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